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1253 124

DRAWINGS ATTACHED

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(54) METHOD OF DEPOSITING VOLATISABLE NON-THERMOSETTING MATERIAL ON TO A SUBSTRATE AND APPARATUS WHEN USED TO CARRY OUT SAID METHOD

(71) We, THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION, a British Company, of 24, Buckingham Gate, London, S.W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method of an apparatus for depositing volatilisable non - thermosetting material, for example epoxy, phenolic (of the Novolak type), or silicone resins or natural oils, etc. onto a substrate, for example, moving steel strip, and to apparatus when used in carrying out said method.

According to one aspect, the present invention provides a method of depositing volatilisable non-thermosetting material onto a substrate comprising the steps of: rotating a surface such that a portion of its travel is adjacent a part of the substrate, depositing said material over the surface when the surface is spaced apart from its position of nearest approach to the substrate, and heating the surface so that as the surface is rotated towards said position of nearest approach the material deposited thereon is vapourised and deposited on the substrate.

According to another aspect, the present invention provides apparatus when used in carrying out the above method comprising a surface, means for rotating the surface so that a portion of its travel is adjacent a part of the substrate, depositing means for depositing said material over the surface when the surface is spaced apart from the its position of nearest approach to the substrate, and heater means for heating the surface so that as the surface is rotated towards said position of nearest approach the material deposited thereon is vapourised and deposited on the substrate.

The apparatus may include means for subjecting said material when deposited on the substrate to ionising radiation to cure said material.

The present invention will be more readily understood from the following description, given by way of example only, reference being made to the following drawings of which Figures 1 to 4 accompanied the Provisional specification and Figures 5 to 7 accompany the present specification.

Figure 1 is a schematic view of an embodiment of the invention;

Figures 2 and 3 are detailed end and front elevation views respectively of the embodiment of Figure 1;

Figure 4 is a part sectional schematic view of a moving strip coating line employing the embodiment of Figure 1, and

Figures 5 to 7 are somewhat schematic views each showing a modification of the embodiment of Figure 1.

The apparatus of the invention will be described with reference to depositing epoxy resin on moving steel strip. Turning to Figure 1, the apparatus there shown comprises a high polish hard-chrome roll 10 mounted for rotation in the clockwise direction as indicated. A reservoir 11 contains the epoxy resin which is to be deposited as a coating on to a moving strip 12 by way of the roll 10. The strip 12 moves in a direction perpendicular to the axis about which the roll 10 rotates. The reservoir is preferably kept at a temperature of the order of 50 to 150° C to keep the resin in a molten state. A positive displacement pump 13 (for example a gear pump) pumps the resin, at the required rate, from the reservoir 11 through a feeder head 14 arranged to deposit the resin on to the roll 10. At the location of the feeder head 14 is an adjustable scraper blade 9.

The roll 10 carries heater elements which heat the surface of the roll on which the resin is deposited. When the heated roll 10

is rotated, a film of epoxy resin is formed on the roll surface. The thickness of this film is determined by the gap between the scraper blade 9 and the roll 10, the rotational speed of the roll 10, the pumping rate of the pump 13 and the viscosity of the hot resin. By controlling the surface temperature of the heated roll, the liquid epoxy resin can be made to evaporate (or "boil" off) and condense on to the strip 12 giving a thin coating of the desired thickness. The surface temperature of the roll will probably be in the range of 150 to 300° C or higher. The evaporated resin is reference 15 in Figure 1.

The deposition of the resin on to the roll 10 and the evaporation and condensation of the resin on to the strip 12 may take place in a vacuum chamber 16. The chamber 16 may be at a vacumm of 0.1 atmospheres or lower. At the entrance and exit locations of the strip 12 into and out of the chamber 16 there would be seals (shown in Figure 4 at 43 and 44) to maintain the desired level of vacuum within the chamber 16.

The ducting connecting the pump 13 to the feeder head 14 may include pre-set regulating valves 17. A bypass duct 18 incorporating a by-pass valve 20 may be provided.

A de-gas pump 21 connected to the reservoir 11 by way of valve 22 may be employed to remove gas from above the surface of the resin in the reservoir.

Turning now to Figures 2 to 4, parts already described with reference to Figure 1 will be given the same reference numerals in Figures 2 to 4 as they have been given in Figure 1.

The roll 10 comprises a cylinder 23 closed at its ends by plates 24. The roll is fast with stub shafts 25. Rotation of the roll 10 is effected by means of a power source not shown. The shafts 25 are received in bearing housings mounted on upstanding supports; one of these supports is shown at 26 in Figure 2.

A number of PYROTENAX (Trade Mark) electric heaters is arranged in circular array around the rotational axis of the roll 10 and the heaters are secured to the end plates 24 of the roll 10 as at 27. Some of these heaters are referenced 28. Electric current is fed to and away from the heaters by way of slip ring collectors 30. Wall portions of the chamber 16 are shown at 31 in Figure 3.

The feeder head 14 has an adjustable width machined slit 32 from which the epoxy resin will be discharged. The width of the feeder head slit can be adjusted by orthodox methods, e.g. screw adjustment or cam-operated adjusting system. The gap 33 between the feeder head and the roll 10 is made adjustable by reason of the feeder head being carried on an adjustable height mounting 34. The feeder head has electric heaters 35, for example "PYROTENAX" heaters, for maintaining the epoxy resin in a molten state.

The ducting connecting the pump 13 to the feeder head 14 comprises a conduit 36 leading to a pipe manifold 37. Pipes 38 take the resin from the manifold 37 into the feeder head 14. Ducts 40 in the feeder head direct the resin to the slit 32.

In Figure 2, the film of resin deposited on the roll 10 is shown at 41, and the resin layer deposited on the strip 12 at 42.

Figure 4 shows (schematically) how depositing apparatus according to the invention could be used in a high speed epoxy resin coating or lacquering plant. Again, items already described have been given the reference numerals previously attributed to them. The moving strip 12 enters the vacuum chamber 16 by way of seal 43 and leaves this chamber by way of seal 44. The strip with the coating of epoxy resin thereon (which resin is radiation-curable) is then cured in the manner disclosed in our British Patent Specification No. 1,168,641. The strip enters (and leaves) a vacuum curing irradiation chamber 45 by way of seal 46; within the chamber 45 the epoxy resin coating at the surface of the strip 12 is subjected to ionising radiation 47 from electron guns 48. Although two guns 48 are shown, there will be only one gun operating to cure the coating that gun being on the same side of the strip as the coating. The ionising radiation 47 cures the coating by polymerising the resin in the coating. The level of vacuum in the chamber 45 may be the same as that quoted in the said Specification No. 1,168,641 for the chamber 11.

The strip is turned in the chamber 45 by means of guide rollers 50. A guide roller 51 turns the strip after exit thereof from seal 46. Seals 43, 44 and 46 may be of known design.

In modified forms of the invention, the heated roll 10 is shrouded with baffles or shields defining a space therebetween opening towards the strip 12. Such an arrangement ensures that the evaporated resin is directed towards the strip 12 and thus losses due to vapourisation from the roll where it is not adjacent the strip are minimised.

Such a modified form is shown in Figure 5 wherein the roll 10 is shrouded with deflection shields 52 for directing stray epoxy resin vapour towards the strip 12. The shields 52 have gutters 53 for trapping liquid epoxy resin not evaporated on to the strip 12. The shields 52 are preferably provided with heaters, (four referenced 54), to keep the shields at the same temperature as the roll surface from which evaporation of the resin takes place. The heaters 54 may be "PYROTENAX" heaters.

Figure 6 shows an alternative design for the shields 52 which, again, are preferably

heated to the same temperature as said roll surface. As an alternative to being arcuate as seen in Figure 6 each shield may comprise two parts disposed at approximately 90° to each other so that the resulting four shields form a generally rectangular outline when seen in end view.

Whereas the embodiments previously discussed can be regarded as direct roller coating embodiments, the embodiment shown in Figure 7 can be regarded as an offset roller coating embodiment. Resin from the head 14 is deposited on the roll 10 and from there is deposited on a roll 10′ which is in driving engagement with the roll 10 so that rotation of roll 10 will cause rotation of roll 10′. The resin layer on the roll 10′ evaporates on to the strip 12. The temperature of the resin receiving surface of the roll 10 will be adjusted so that the resin thereon will be maintained in the molten state but below the vapourisation state. 10′ is the evaporator roll and the resin receiving surface thereof is heated, for example by "Pyrotenax" heaters, to a temperature at which the liquid epoxy resin thereon will evaporate (or "boil" off) and condense on to the strip 12. Shields 52 in the Figure 7 embodiment serve the same purpose as the shields 52 in the embodiments of Figures 5 and 6 and are preferably heated.

Advantages of the Figure 7 embodiment over the other embodiments are that the epoxy resin coating on the roll 10′ of Figure should be thinner and more uniform than the coatings on the rolls 10 of the other embodiments, and a more uniform coating on the strip 12 will result.

Of course, like reference numerals in all of Figures 1 to 7 indicate like parts.

The alternative forms of depositing apparatus shown in Figure 5 to 7 may replace the particular form of such apparatus shown in the coating or lacquering plant of Figure 4.

This invention may be used to deposit non-thermosetting material other than epoxy resin or lacquer on to a substrate which may be stationary instead of moving, the depositing apparatus then being mounted for movement relative to the substrate. The said substrate may be strip other than steel strip. The said substrate may not be metal strip. The said substrate may not be strip. The said substrate may be wire for example. The apparatus of the invention is however particularly suitable for moving strip or web.

Preferably, the roll 10 or when used roll 10′ rotate continuously in the directions indicated so that the material to be deposited on the substrate is continuously deposited on to the roll 10, 10′ from the feeder head 14 or from the roll 10 and continuously evaporates (or "boils" off) and condenses on to the substrate.

WHAT WE CLAIM IS:—

1. A method of depositing volatilisable non-thermosetting material onto a substrate comprising the steps of: rotating a surface such that a portion of its travel is adjacent a part of the substrate, depositing said material over the surface when the surface is spaced apart from its position of nearest approach to the substrate, and heating the surface so that as the surface is rotated towards said position of nearest approach the material deposited thereon is vapourised and deposited on the substrate.

2. A method according to claim 1 including shrouding the surface in such a manner that vapourised material to be deposited is directed towards the substrate.

3. A method according to claim 1 or claim 2 in which the surface is cylindrical, said material being deposited thereon at a position substantially diametrically opposite said position of nearest approach.

4. A method according to any preceding claim comprising depositing said material onto a rotating further surface and depositing said material from said further surface onto said first-mentioned surface.

5. Apparatus when used in carrying out the method of claim 1 comprising a surface, means for rotating the surface so that a portion of its travel is adjacent a part of the substrate, depositing means for depositing said material over the surface when the surface is spaced apart from its position of nearest approach to the substrate, and heater means for heating the surface so that as the surface is rotated towards said position of nearest approach the material deposited thereon is vapourised and deposited on the substrate.

6. Apparatus according to claim 5 including shroud means for shrouding the surface so that vapourised material deposited thereon is directed towards the substrate.

7. Apparatus according to claim 6 in which the shroud means comprises baffles or shield plates defining a space therebetween opening towards the substrate.

8. Apparatus according to claim 6 or 7 wherein said shroud means has gutter means for trapping liquid unevaporated material.

9. Apparatus according to any one of claims 5 to 8 in which the depositing means comprises a rotatable further surface for transferring material deposited thereon to the first-mentioned surface.

10. Apparatus according to any one of claims 5 to 9 including means for controlling the quantity of material deposited on the first-mentioned or the further surface.

11. Apparatus according to any one of claims 5 to 10 including means for subjecting said material when deposited on the substrate to ionising radiation to cure said material.

12. A method of depositing volatilisable

non-thermosetting material onto a substrate substantially as herein described with reference to Figures 1 to 4 of the drawings accompanying the Provisional specification.

13. A method according to claim 12 as modified substantially as herein described with reference to the accompanying Figure 5.

14. A method according to claim 13 as modified substantially as herein described with reference to the accompanying Figure 6.

15. A method according to claim 13 as modified substantially as herein described with reference to the accompanying Figure 7.

16. Apparatus for use in carrying out the method of claim 1 and substantially as herein described with reference to and as shown in Figures 1 to 4 of the drawings accompanying the Provisional specification.

17. Apparatus according to claim 16 as modified substantially as herein described with reference to and as shown in the accompanying Figure 5.

18. Apparatus according to claim 17 as modified substantially as herein described with reference to and as shown in the accompanying Figure 6.

19. Apparatus according to claim 17 as modified substantially as herein described with reference to and as shown in the accompanying Figure 7.

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1253124 PROVISIONAL SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

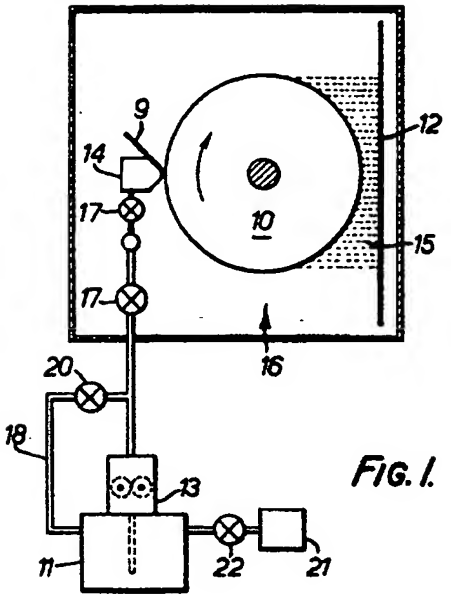

FIG. 1.

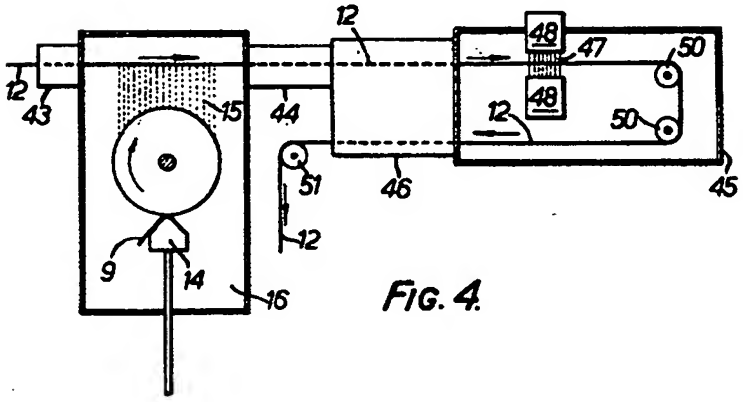

FIG. 4.

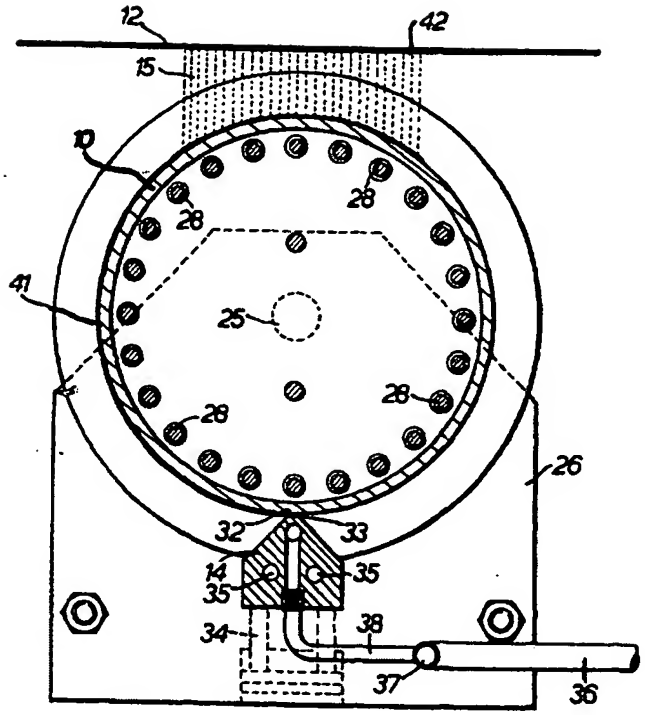

FIG. 2.

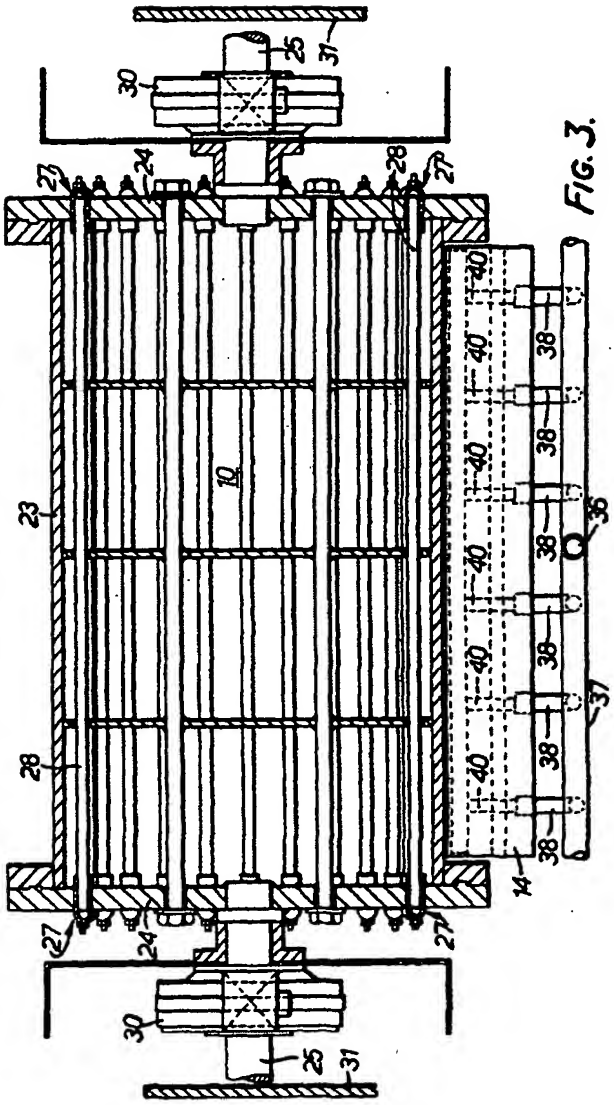

FIG. 3.

1253124 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

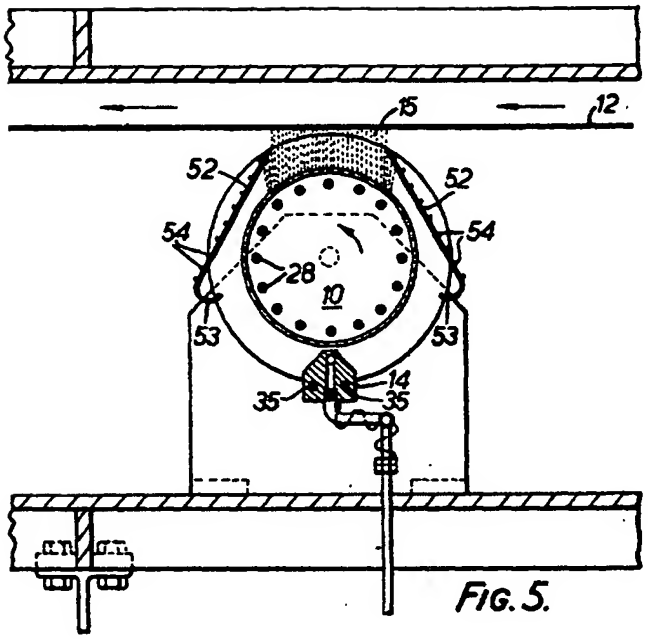

FIG. 5.

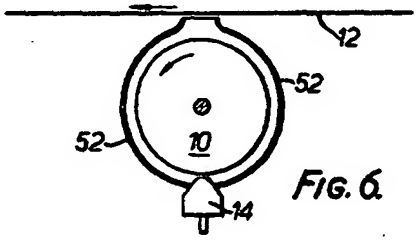

FIG. 6.

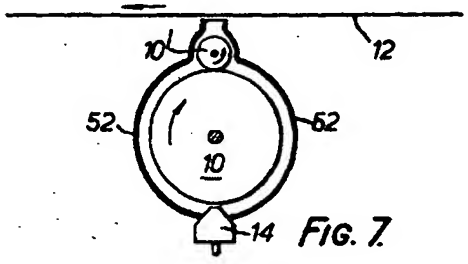

FIG. 7.